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Improving student achievement in Mathematics approaching small-group learning and whole-class discussion: in the Case of First Year Mathematics Students of Mettu University, Ethiopia

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Abstract: The objective of the study was to examine the effects of small-group learning and whole-class discussion on students' mathematics achievement. The study also sought to determine the small-group learning and whole-class discussion load that affects student mathematic achievement. In order to conduct the study an approach of action research was employed on one section of First Year Mathematics Students of Mettu University. First observation of students' activity and their perception towards mathematics small-group learning and whole-class discussion was made. Students' perceptions of small-group learning and whole-class discussion gave valuable information to improve the approaches of small-group learning and whole-class discussion so as to improve student achievement. In the first session of observation and focus group discussion the researcher at glance concluded that students were overloaded and they perceive negative attitude towards small-group learning and whole-class discussion that exhibit low achievement and next designed a strategy with partner researcher. Therefore, action was taken to improve approaches of small-group learning and whole-class discussion by dividing students as an experimental (32) and control group (32). An experimental group students were exposed two representative examples and two representative questions for the five small-group learning and the whole-class discussion with appropriate time allotment followed by evaluation, while the control group were continued as usual as on the same instruction, topics and sections of chapters for about 4 months and their four test scores given at the end of every months , were analyzed using independent sample t- test as shown in the methodology section. Furthermore, their perception before and after the new exposure of small-group learning intervention for experimental group was analyzed using dependent t-test. The result shows that statistically significant difference test performance between an experimental and controlled group of students. Moreover, students' perception towards small-group learning and whole-class discussion on mathematics course was significantly improved for an experimental group. The study revealed that only appropriate and relevant small-group learning and whole-class discussion activity with clear classroom demonstration, equitable activity followed with classroom evaluation and time allotment can improve students mathematics achievements than loading student with full of activities and classroom instructional obstruction.

Keywords: Improving, small-group learning, whole-class discussion, Students' achievement

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I. Introduction

Considerable research evidence within mathematics education indicates that using small groups of various types for different classroom tasks has positive effects on student learning. Davidson, for example, reviewed almost eighty studies in mathematics that compared student achievement in small-group settings with traditional whole-class instruction. In more than 40% of these studies, students in the classes using small-group approaches significantly outscored control students on measures of student performance. In only two of the seventy-nine studies did control-group students perform better than the small-group students, and in these studies there were some design irregularities.

From a review of ninety-nine studies of co-operative group-learning methods at the elementary and secondary school levels, Slavin concluded that co-operative methods were effective in improving student achievement. The most effective methods emphasized both group goals and individual accountability.

From a review by Webb of studies examining peer interaction and achievement in small groups, several consistent findings emerged. First, giving an explanation of an idea, method or solution to a team mate in a group situation was positively related to achievement. Second, receiving 'non-responsive' feedback (no feedback or feedback that is not pertinent to what one has said or done) from team mates was negatively related to achievement. Webb's review also showed that group work was most effective when students were taught how to work in groups and how to give and receive help. Received help was most effective when it was in the form of elaborated explanations (not just the answer) and then applied by the student either to the current problem or

to a new problem. Using small groups of students to work on activities, problems and assignments can increase student mathematics achievement.

Qualitative investigations have shown that other important and often unmeasured outcomes beyond improved general achievement can result from small-group work. In one such investigation, Yackel, Cobb and Wood studied a second-grade classroom in which small-group problem solving followed by whole-class discussion was the primary instructional strategy for the entire school year. They found that this approach created many learning opportunities that do not typically occur in traditional classrooms, including opportunities for collaborative dialogue and resolution of conflicting points of view.

Slavin's research showed positive effects of small-group work on cross-ethnic relations and student attitudes towards school.

In the classroom:Research findings clearly support the use of small groups as part of mathematics instruction. This approach can result in increased student learning as measured by traditional achievement measures, as well as in other important outcomes. When using small groups for mathematics instruction, teachers should:

- choose tasks that deal with important mathematical concepts and ideas;
- select tasks that are appropriate for group work;
- consider having students initially work individually on a task and then follow this with group work where students share and build on their individual ideas and work;
- give clear instructions to the groups and set clear expectations for each;
- emphasize both group goals and individual accountability;
- choose tasks that students find interesting;
- Ensure that there is closure to the group work, where key ideas and methods are brought to the surface either by the teacher or the students, or both.

Finally, as several research studies have shown, teachers should not think of small groups as something that must always be used or never be used. Rather, small-group instruction should be thought of as an instructional practice that is appropriate for certain learning objectives, and as a practice that can work well with other organizational arrangements, including whole-class instruction.

Research findings Research suggests that whole-class discussion can be effective when it is used for sharing and explaining the variety of solutions by which individual students have solved problems. It allows students to see the many ways of examining a situation and the variety of appropriate and acceptable solutions.

Wood found that whole-class discussion works best when discussion expectations are clearly understood. Students should be expected to evaluate each other's ideas and reasoning in ways that are not critical of the sharer. This helps to create an environment in which students feel comfortable sharing ideas and discussing each other's methods and reasoning. Furthermore, students should be expected to be active listeners who participate in the discussion and feel a sense of responsibility for each other understands.

Cognitive research suggests that conceptual change and progression of thought result from the conflict during whole-class discussion have considerable potential for increasing student learning when carefully managed by the teacher. As students address challenges to their methods, they strengthen their understanding of concepts and procedures by working together to resolve differences in thinking or confusions in reasoning. In a sense, the discussion becomes a collaborative problem-solving effort. Each individual then is contributing to the total outcome of the problem-solving situation. This discussion helps produce the notion of commonly held knowledge (public knowledge).

In the classroom:It is important that whole-class discussion follow student work on problem-solving activities. The discussion should be a summary of individual work in which key ideas are brought to the Surface. This can be accomplished through students presenting and discussing their individual solution methods or through other methods of achieving closure that are led by the teacher, the students, or both.

Whole-class discussion can also be an effective diagnostic tool for determining the depth of student understanding and identifying misconceptions. Teachers can identify areas of difficulty for particular students, as well as ascertain areas of student success or progress.

Whole-class discussion can be an effective and useful instructional practice. Some of the instructional opportunities offered in whole-class discussion do not occur in small group or individual settings. Thus, whole-class discussion has an important place in the classroom together with other instructional practices.

The instruction given to the students in actual classroom refers to traditional approaches which may deny the small-group learning and whole-class discussion. Most students are complaining of mathematics courses as difficult subject. They always busy in studying mathematics course during examination time only. These facts are the real situation observed in Mettu University which needs intervention in small-group learning and whole-class discussion so as to enhance students' achievement in mathematics course. Thus, this study

focuses to realize how small-group learning and whole-class discussion affects achievement in mathematics course. The present study is trying to answer the following questions:

1. What are the perceptions of students towards small-group learning and whole-class discussion?
2. To what extent small-group learning and whole-class discussion affect the performance of students in mathematics achievements?

1.2. Objectives of the Study

- To observe attitudes of students towards small-group learning and whole-class discussion in mathematics course.
- To analyze whether or not approaches of small-group learning and whole-class discussion affect achievements in mathematics course.

1.3. Significance of the Study

The researcher hope that the outcomes of this study will:-

- Help teachers to know the small-group learning and whole-class discussion improve student's achievement in Mathematics course and it will have a basis for practitioners to practice experimental action research in their respective classroom.
- Help the students to participate actively in Mathematics lessons (small-group learning and whole-class discussion) minimizing or avoiding the factors that interrupt their participation.
- Helps for the improvement of quality education.

1.4. Scope of the Study

Even though variables attributing students' performance in mathematics course are multidimensional and controversial, the study was delimited to small-group learning and whole-class discussion activities loads during instruction only. Furthermore study was carried out only in one sections divided into two; one as experimental and the other as controlled, of first year mathematics students of Mettu University.

II. Research Design And Methodology

The design of the study was static-group comparison -experimental action research approach which fit the nature of the study. The description of a proposed study design was to determine students' perception of small-group learning and whole-class discussion approaches that predict students' achievement. The approaches of small-group learning and whole-class discussion were considered as independent variable while student achievement on the tests was seen as dependent variable.

Procedure

Participants based on the nature of the topic and the researcher interest to apply action research approaches, purposive sampling techniques was employed for deeper understanding of effects of small-group learning and whole-class discussion on mathematics achievement for articulating an area of intervention. The participants for my action research were first year mathematics students of Mettu University. I conducted my research in a mathematics (linear algebra) class. 23 of the 64 students are female and 41 are male students. These students were selected because of the fact that they have been with the researcher for the previous semester with similar courses. Thus, the principle of experimental based action research on actual classroom basis was believed to be effective, irrespective of students' various socio-economic backgrounds.

I started my inquiry by administered/divided one sections into two sections experimental group and control groups of my first year mathematics students. The students (experimental group) answered questions (twice before and after intervention activities) using a five-point scale from strongly disagree to strongly agree (table 1), which helps to compare students' perception towards mathematics small-group learning and whole-class discussion before and after intervention strategies.

During my pre-service teaching, I taught four units: **vectors, matrices, determinants, and system of linear equations**. I observed and collected a data set during each of these units (taken tests to both of experimental group and controlled groups, table2). The first data set was collected from February 3rd through February 24th, the second data set was collected from March 3rd through March 24th, the third data set was collected from April 3rd through April 24th and the fourth data set was collected from May 3rd through May 24th. During this data set, the following procedures were employed for experimental group: 60 minutes of total instruction time allotment was ensured 30 minutes lecture with two clear examples were demonstrated to the class. Two questions were given for small group learning to be done for 15 minutes and for whole class discussion to be done for 15 minutes. And for control group: Full lecture (traditional instruction) and example without time allotment for each activity. Lots of computational exercise was given as a home work, No small-group learning and whole-class discussion. Furthermore the students were ordered to practice similar activities in their text book. It noted that the intervention strategy were time allotment, two representative practical

examples and classroom group activities and evaluation which were employed on experimental group. On the other hand no intervention was made for control group.

2.4. Methods of Data Analysis

First of all the score of first semester result of both experimental and control group was analyzed using independent sample t- test as a bench mark achievement before intervention(table 3). The perception and performance of students before and after classroom intervention and the result of test score were analyzed by statistical tools such as dependent and independent t-tests, respectively.

III. Results And Discussion

Before class room intervention students' perception has been analyzed. The pre-intervention and post - intervention of students' perception towards small-group learning and whole-class discussion analyzed as is shown in Table1. 32 students from experimental group were involved in rating the items before and after intervention, and dependent t-test employed to show how classroom intervention improve students' perception towards small-group learning and whole-class discussion in mathematics class.

Table1: dependent t-test analysis students' perception towards small-group learning and whole-class discussion

items	Intervention cases	N	Mean	Standard deviation	t	p
1. small-group learning and whole-class discussion Can improve students achievement in mathematics	Pre-intervention	32	3.89	1.098	0.892	0.376
	Post-intervention	32	3.97	1.279		
2. small-group learning and whole-class discussion is to kill or waste time	Pre-intervention	32	3.97	1.018	3.649	0.001
	Post-intervention	32	2.86	1.291		
3. No need of giving small-group learning and whole-class discussion	Pre-intervention	32	2.917	0.937	5.447	0.001
	Post-intervention	32	1.583	1.131		
4. home work is preferable to small-group learning and whole-class discussion	Pre-intervention	32	3.111	1.237	0.993	0.324
	Post-intervention	32	2.833	1.134		
5. most students who perform small-group learning and whole-class discussion are not successful in examination	Pre-intervention	32	2.694	1.090	4.8	0.001
	Post-intervention	32	1.611	0.803		
6. Always I disturbed when small-group learning and whole-class discussion is given	Pre-intervention	32	2.333	0.925	1.488	0.141
	Post-intervention	32	1.9167	1.401		
7. I dislike small-group learning and whole-class discussion at all	Pre-intervention	32	2.167	0.878	1.994	0.052
	Post-intervention	32	1.694	1.116		

Table1 shows that students' perception towards small-group learning and whole-class discussion significantly improved on items 2, 3, 5, and 7. One can deduce that the intervention made has developed positive attitudes of students towards mathematics small-group learning and whole-class discussion. Comparatively however, still there are some students who are always disturbed when small-group learning and whole-class discussion is given as referred in item6 in Table 1.

In order to compare the result of students' achievement after intervention first semester result (100%) was taken as a basis of the study and the result is shown in Table 2.

Table2: First semester result analysis as bench mark for intervention

Test	group	N	Mean	Standard deviation	t	p
First semester result (100%)	Experimental group	32	53.19	16.243	0.66	0.947
	Control group	32	52.91	14.477		

The Table2 above shows that there is no statistically significant difference observed between experimental and controlled groups in their first semester achievements'.

Thus it is easy to justify whether classroom intervention can improve students' achievement by comparing both experimental and controlled groups' achievement after intervention: The four mean score tests for 32 students (experimental group) and the mean score for 32 students (controlled group) were analyzed. Independent t-test was employed to test whether statistically significant achievements on tests were observed or not, the result was shown in Table 3 below. The result in Table3 indicates that there is statistically significant difference observed between an experimental group and controlled group in all the four tests and their sums (100%):

Table3: comparison of students' achievement during classroom intervention

Tests	Groups	N	Mean	Standard deviation	t	p
Second semester result T1+T2+T3+T4 =100%	Experimental group	32	67.6	9.78	3.668	0.001
	Control group	32	55.07	12.39		

*p<0.005: shows statistically significant

Especially, Table 3 clearly shows that students who have got treatment in their respective small-group learning and whole-class discussion have improved their academic achievement better than those who didn't get small-group learning and whole-class discussion treatments. This fact demonstrate that the effect of appropriate

small-group learning and whole-class discussion improve the performance of students in mathematics course. Overall, the experimental group students have shown better performance in the second semester result. This study indicates that appropriate small-group learning and whole-class discussion improve students' academic achievement in mathematics. This finding goes with that study which recommends classroom instruction a base for mathematics achievement (Silesh, 2000).

The literature points to the fact that the small-group learning and whole-class discussion, teacher instructional quality and student attitude are part of the many areas that affect student achievement in mathematics (Fraser, 1998). Small-group learning and whole-class discussion and evaluation are not only provides information on how to measure the students' performance, but also information on the teachers' competences to create the positive learning outcomes..

From the findings of the study, the researcher concludes that:

- The independent variables, approach of small-group learning and whole-class discussion and evaluation is statistically significant to student mathematics achievement scores,
- The classroom small-group learning and whole-class discussion and task orientation and time allotment for activities had an interesting contribution on students' mathematics achievement.

IV. Implications Of The Study

The data collected and the results of the study have many prospective implications for the improvement of students' performance in mathematics course and instructors of mathematics courses. The importance of creating and maintaining appropriate small-group learning and whole-class discussion, time allotment of each activity and evaluation are crucial to ensure and maintain a positive impact on student achievement. However, there are still many questions that are still unanswered relating to approaches of small-group learning and whole-class discussion and mathematics achievement. Hence, other factors exist that can affect small-group learning and whole-class discussion and student mathematics achievement in our University. These include factors such as teacher effectiveness, socio-economic and classroom physical setting. Therefore, there is a need for subsequent studies that will support this study and add the development of practical experimental action research and additional classroom instructional studies and findings for the development of mathematics education in our country at larger scale. Mathematics teachers had better encourage appropriate small-group learning and whole-class discussion that initiate students' performance. Students should exercise mathematics activities with their teacher in the class rather than reserving as homework. Teachers need to identify desirable and undesirable practices in small-group learning and whole-class discussion in order to improve their students' mathematics achievement. Teachers need to ensure that students are equitably relaxed on few representative practical examples and do small-group learning and whole-class discussion within specified time.

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